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Chapter Eighty-two

TRAFFIC CONTROL PLANS/DESIGN

To some extent, highway construction disrupts the normal flow of traffic and poses safety hazards to motorists, bicyclists, pedestrians and workers. Therefore, to alleviate potential operational and safety problems, INDOT requires that work zone traffic control be considered on every highway construction project. The work zone traffic control plan may range in scope from very detailed design plans, or to incorporation of Special Provisions or Recurring Special Provisions, or to merely referencing the INDOT *Standard Drawings, Standard Specifications* and the *Manual on Uniform Traffic Control Devices (MUTCD)*. Chapter Eighty-two provides the necessary information to develop a well-conceived work zone traffic control plan that minimizes the adverse effects of traffic disruption and hazards.

82-1.0 PRELIMINARY ENGINEERING

82-1.01 Responsibilities

The Environment, Planning and Engineering Division's Engineering Assessment Section is responsible for initially addressing work zone traffic control on every project. This information is to be included in the Engineer's Report. In determining the initial work zone traffic control, the Engineering Assessment Section will perform the following:

1. collect all necessary data (e.g. traffic counts, accident history, roadway geometrics, proposed development, operating speeds);

2. coordinate planning and scoping meetings with the applicable participants (e.g., Design, Traffic, District Development, Maintenance, Construction, Operations Support, local officials);

3. conduct analyses (e.g., capacity analyses, traffic impact studies, safety studies, queuing analysis);

4. review design alternates;

5. review traffic control alternates (e.g., detours, crossovers, runarounds, lane closures); the preferred plan will be incorporated into the Report;

6. estimate the construction cost and economic impact of various options and improvements;

7. coordinate funding and timing with other projects within the corridor; and

8. if required, form a transportation management plan team for the project and include the team's recommendations in the Report. Chapter Eighty-one provides information on the development of transportation management plans.

82-1.02 District Input

During the development of the Engineer's Report, the Engineering Assessment Section will obtain the following information from the district.

1. The district concurrence for the selected traffic control alternate;
2. location and additional distance of the detour;
3. traffic projections anticipated to use detour;
4. any anticipated delay to fire, police, emergency-medical and postal service;
5. number of school buses using facility (additional delay and distance); and
6. local roads which may be used for an official and unofficial detour.

82-1.03 Engineer's Report

The Engineering Assessment Section will be responsible for incorporating the proposed work zone traffic control plan in the Engineer's Report and ensuring that the following have been considered.

1. <u>Traffic Control Alternates</u>. The Report may address the following work zone traffic control information.

    a. Applicability of INDOT *Standard Drawings*;
    b. alternate traffic control strategies;
    c. alternate detour types and locations;
    d. construction scheduling and phasing requirements;
    e. alternate geometric design features;
    f. estimated costs for the alternate traffic control strategies; and
    g. any special requirements of the work zone traffic control.

2. Construction Operation Selection. The following construction applications may be considered.

   a. Work beyond the shoulder;
   b. shoulder work and partial lane closure;
   c. lane closures for 2-lane highways;
   d. single-lane closures for 4-lane highways;
   e. two-way traffic on divided highways;
   f. work within or near intersections;
   g. offset alignments; and
   h. official and local detours (e.g., runarounds, crossovers).

   Chapter Eighty-one provides additional guidance for determining which of these various construction applications may be appropriate.

3. Detour Location. The use of detours (e.g., runarounds, crossovers, alternate routes) should be determined on a project-by-project basis. The detour location should:

   a. minimize impacts to adjacent developments (e.g., site access);
   b. minimize the magnitude and cost of utility relocations;
   c. minimize environmental impacts; and
   d. be offset a sufficient distance so it will not interfere with construction.

   The Department may be required to repair county highways damaged while being used as unofficial detour routes. See the INDOT Detour Policy for additional information. Investigations, details and agreements with local officials may be required in subsequent phases.

4. Community Impacts. The Report may address the impacts on neighborhoods, parks, schools, businesses, etc. Detours can significantly increase traffic through a community such that local traffic can no longer use the detour route. The Report may also address how the work zone traffic control will affect fire, ambulance, police and school bus routes.

5. Interest Groups. The Report should address the concerns of local governments, agencies, public officials and special interest groups (e.g., homeowner associations). If reasonable, changes should be made to the work zone traffic control that address their concerns. Working with local officials and organizations early in project development can significantly reduce opposition to or create support for a project by addressing local concerns.

6. Transportation Management Plan. Where a project does not warrant the development of a Transportation Management Plan (TMP), the Engineering Assessment Section still should

review Chapter Eighty-one for applicable guidelines and criteria that should be discussed during this phase. The conclusion of this phase should result in a reasonable traffic control strategy for the project.

82-2.0 PLAN DEVELOPMENT

82-2.01 Responsibilities

On all INDOT or local transportation highway construction projects, it is the designer's responsibility to ensure that an adequate traffic control plan (TCP) is developed. If the traffic control requirements are not covered completely by the INDOT *Standard Drawings* and *Standard Specifications*, then the designer should prepare a TCP that will adequately address all non-standard traffic control items in the project. The designer will be responsible for the following:

1. reviewing the information in the Engineer's Report or, if not available, contacting the appropriate unit or agency (e.g., traffic design units, FHWA) to obtain the necessary information for the project;

2. evaluating the proposed project design alternates (e.g., detours, crossovers, runarounds, lane closures); see Chapter Eighty-one;

3. developing the geometric design for specially constructed detours (e.g., crossovers, runarounds, offset alignments); see Section 82-3.0;

4. addressing the roadside safety concerns within the construction zone (e.g., construction clear zones, temporary concrete barriers); see Section 82-4.0;

5. selecting and locating the required traffic control devices (e.g., pavement markings, barricades, signs); see Chapter Eighty-three;

6. developing and evaluating alternate construction sequences;

7. performing the necessary capacity and queuing analyses, if not already provided;

8. making a written request to the Materials and Tests Division's pavement design engineer regarding use of shoulders or their portions for traffic maintenance. A copy of the request should be sent to the appropriate design project coordinator. The request should include the construction year AADT, percent trucks of AADT, and the approximate duration of traffic's shoulder use;

9. ensuring that the proposed traffic control plan is discussed and reviewed during the Preliminary Field Check; and

10. coordinating with public information officials to inform the public of proposed road closures, detour routes, etc.

82-2.02 Plan Development

The TCP is developed through several phases before it is ready to be incorporated into the highway construction contract and approved for letting. The following describes the development of the traffic control plan at each project phase.

1. Engineer's Report. The Engineering Assessment Section will be responsible for determining the initial work zone traffic control strategies to be used on the project. These should be noted in the Engineer's Report. If any changes are made to the recommendations in the Report, the designer should notify the Engineering Assessment Section of these changes.

2. Structure Size and Type (Bridge Replacement Project) or Grade Review (Sight Distance Improvement or Small Structure Replacement. At this plan development stage, the designer is responsible for contacting the appropriate district to obtain its input regarding traffic maintenance. Figure 82-2B is a blank memorandum copy which the designer should download, fill in the project information blanks, then transmit to the district. District input should be solicited even if a TCP is specified in the Engineer's Report. The district should provide the requested information to the designer.

3. Preliminary Field Check. During the Preliminary Field Check, review the proposed traffic control strategy against actual and anticipated field conditions and be prepared to perform the following tasks.

    a. Drive the local detour;

    b. determine the environmental effects of a crossover or runaround;

    c. estimate the extent and cost of property damage caused by a crossover or runaround, including additional right-of-way requirements and costs;

    d. determine the feasibility of maintaining traffic on the facility (e.g., roadway, bridge) while work is in progress;

e. evaluate the need for scheduling work activities to avoid traffic delays during peak commuter hours and local events;

f. determine the effects on project constructability; and

g. review the physical and operational elements of the TCP with other projects in the area to ensure that there are no conflicts with the proposed TCP.

At the conclusion of this phase of the project, the preliminary geometric design, safety and capacity analyses should be completed and suggested plan modifications evaluated and reviewed. The designer should determine the proposed location of all traffic control elements and special design elements (e.g., runarounds, crossovers) and should establish the proposed construction phasing. The designer should contact the district for its input, even if the proposed TCP is recommended in the Engineer's Report.

4. Hearing. The project's plan and profile, cross-sections, construction schedule/phasing and impact reports should be completed at this stage. Begin preparation of the required special provisions and the permit process. Prepare an estimate of the time required to re-open the facility (e.g., roadway, bridge) to traffic after construction starts.

5. Final Field Check. Review all issues emerging from the hearing stage and complete subsequent plan modifications. Review the project's physical and operational elements of the TCP with other projects in the area to ensure that there are no conflicts with the proposed TCP. Examples include detouring traffic onto a local road which is scheduled for reconstruction during the same time period or closing a highly traveled highway during special events or seasons. Coordinate with the Office of Communications so that they can begin to inform the public of any road closures or alternate detour routes.

6. District Construction Engineer Review. After design approval, the designer should submit the proposed TCP to the district construction engineer. The district construction engineer will provide written comments or concurrence regarding the proposed TCP to the designer, with a copy to the appropriate Design Division section manager. The section manager will provide written comments or concurrence regarding the proposed TCP to the designer. If necessary, the designer revises the proposed TCP until both district construction engineer and section manager concur.

7. Final Plan Review. Determine and check all quantity estimates. Complete the detailed drawings and include all relevant special provisions in the contract documents. Do not show unofficial detour routes in the plans or special provisions.

The Department requires a coordinated team effort to develop and successfully implement a TCP. Figure 82-2A presents the participants typically involved in each phase of its development.

82-2.03 Traffic Control Plan (TCP) Content

The size and type of a project greatly impacts the amount of information required in the TCP. For example, for a traffic-signs project the TCP may only be a listing of the appropriate INDOT *Standard Drawings*. However, for a freeway reconstruction project the TCP may contain full-size drawings, special details, special provisions, special task forces, etc. The TCP content will be determined on a project-by-project basis. The TCP may include the following.

1. Construction Plan Sheets. A reconstruction project will typically require very detailed plans for accommodating traffic at each construction stage (e.g., specially built detours, crossovers, staged construction). These plans may include geometric layout details, positive protection strategies, the traffic control devices, etc. A smaller project (i.e., partial 3R, traffic signs, signals, or a spot improvement) will rarely require this level of detail. Chapters Fourteen and Fifteen present the Department's plan preparation criteria (e.g., sheet sizes, scales, line weights, CADD symbols) which are also applicable to a TCP. The INDOT *Typical Plan Sheet Document* presents several traffic maintenance detail sheet examples.

   A traffic maintenance plan that requires at least one shoulder to carry traffic on a temporary basis during construction should include information regarding shoulder corrugation installation requirements. A note should be included that reads, "Corrugations shall not be milled into the _____ shoulder between Sta. _____ and Sta. _____ until after traffic is no longer temporarily using the shoulder."

2. Special Provisions. Special provisions are used to explain special procedures, materials or equipment used in the TCP that are not addressed in the INDOT *Standard Specifications*. For many projects, the TCP may only consist of special provisions. Prior to developing a new special provision, the designer should first ensure that it is not already covered in the INDOT *Standard Specifications*, Supplemental Specifications or recurring special provisions. Chapter Nineteen provides information on the requirements for preparing special provisions.

3. Traffic Control Devices. Include a complete listing of the various traffic control devices required to direct traffic through the work zone in the TCP. This may include the number of drums, barricades, cones, signs, temporary pavement markings, warning lights, flashing arrow boards and other devices that are required to implement the project. Chapter Seventeen provides the Department's criteria for determining plan quantities.

4. Construction Sequence/Time. The TCP should include a proposed construction sequence.

5. Work Schedules. The TCP, in the special provisions, should clearly delineate any restricted work schedules a contractor will be required to follow (e.g., no construction work during specified hours or days).

6. Phone Numbers. The TCP, in the special provisions, should require the contractor to provide names and telephone numbers of the contractor's superintendent and one other responsible employee. These employees are to be on call or be available at night, on weekends or other non-construction time periods to repair or replace traffic control devices and other devices which may become damaged or inoperative (e.g., replacement of construction-zone end treatments).

7. Permits. For restricted lane widths, the district construction section will be responsible for coordinating with the Contracts and Construction Division's Permit Services Section after the project is let to obtain the necessary permits to allow oversize vehicles through the work zone.

8. Agreements/Legal Releases. An agreement and/or legal release may be required before INDOT can use local road facilities as detour routes. The designer should initiate this process early in the design of the work zone traffic control.

9. Media. The designer should inform the Office of Communications when and where there will be major road and ramp closures or detours.

10. Pedestrians/Bicycles. The TCP should address the safe accommodation of pedestrians and bicyclists through the work area. In addition, construction phasing may need to be scheduled around non-peak pedestrian times.

11. Local Businesses/Residents. Maintain at least one reasonable access to sites of business establishments and residential neighborhoods. The designer should also ensure these individuals are kept informed of any planned street, ramp or driveway closures.

12. Emergency Vehicles. The TCP should address the safe and efficient accommodation of emergency vehicles through the construction area.

13. Check List. Section 82-7.0 provides a check list which should be reviewed to ensure all applicable work zone traffic control elements have been addressed in the TCP.

82-2.04 Design Considerations

The objective of the TCP is to provide an implementation strategy that will minimize the adverse effects of traffic disruption on motorists, pedestrians, bicyclists and workers. Therefore, the designer should consider the following design considerations when developing the TCP. For a more in-depth analysis on these elements, the designer should review Chapter Eighty-one.

82-2.04(01) Engineering

The designer should consider the following engineering elements when developing the TCP.

1. Geometrics. The TCP should provide adequate facilities for drivers to safely maneuver through the construction area, day or night. The design should avoid frequent and abrupt changes in roadway geometrics, such as lane narrowing, lane drops and transitions which require rapid maneuvers. Section 82-3.0 presents geometric design criteria for construction zones.

2. Roadside Safety. Motorist, pedestrian, bicyclist and worker safety is a priority element of any TCP and should be an integral part of each phase of the construction project (i.e., planning, design and construction). Section 82-4.0 addresses the roadside safety issues typically encountered during construction.

3. Highway Capacity. The TCP should, where practical, provide the capacity necessary to maintain an acceptable level-of-service for the traveling public. This may require converting shoulders to travel lanes, eliminating on-street parking, constructing temporary lanes, opening additional lanes during peak periods or expanding public transportation. Section 82-5.0 provides further information on highway capacity issues.

4. Traffic Control Devices. Traffic control devices should be included in the TCP to safely direct vehicles through or around the construction zone. Chapter Eighty-three provides guidance on the selection and location of traffic control devices in construction zones.

5. Overhead Lighting. The design should maintain existing overhead lighting and, on a case-by-case basis, consider the need for supplemental roadway lighting at potentially hazardous sites within the work area. Chapter Eighty-three discusses the use of construction zone lighting.

82-2.04(02) Constructability

The designer should evaluate the construction sequence of the proposed TCP to identify any safety, operational or logistical problems and to facilitate the timely completion of the project. Some of the elements which should be evaluated include the following:

1. the maneuverability of traffic through horizontal and vertical alignments during all construction phases;

2. the separation of opposing traffic, workers, equipment and other hazards;

3. the work areas which will be used for equipment maneuverability; and

4. the access points to work and material storage sites.

> ** *PRACTICE POINTER* **
>
> Adequate working space between the traffic and the work area should be provided. This applies especially where construction is phased or if the project includes a temporary runaround.

82-2.04(03) Construction Design

Several construction options are available that may improve the TCP. Some of these options include the following:

1. The use of special materials (e.g., quick curing concrete that can support vehicular loads within hours after pouring);

2. the use of special designs (e.g., using precast box culverts instead of cast-in-place box culverts or bridges);

3. special scheduling requirements which will reduce traffic disruptions (e.g., working at night and during off-peak hours);

4. project phasing which will allow traffic to use the facility prior to project completion; and

5. contractor cost incentives/disincentives for early/late completion of construction for facilities with a high AADT. Where there is FHWA oversight, contractor incentives must be approved by the FHWA.

Chapter Eighty-one provides additional information on construction alternates.

82-2.04(04) Economic/Business

The designer needs to consider the economic impacts a TCP may have on road-users, adjacent businesses and residential developments. The designer should consider the following:

1. Vehicular travel time;
2. fuel consumption;
3. vehicular wear;
4. air pollution;
5. access to residential developments;
6. patron access to businesses (e.g., restaurants, gas stations, stores);
7. employee and delivery access to commercial developments; and
8. shipments to manufacturing companies.

The designer should also review the TCP to ensure that it does not restrict access to businesses during peak retail shopping periods. For example, a road closure should not be made in the vicinity of regional retail malls during the period from Thanksgiving to Christmas. Coordination with local businesses, developers and other land owners should be made early in the development of the TCP. At a minimum, maintain at least one access to any development throughout the project.

82-2.04(05) Pedestrians/Bicyclists

Address the safe accommodation of pedestrians/bicyclists through the construction zone early in project development. Situations that would normally warrant special pedestrian/bicyclist considerations may include the following:

1. Locations where sidewalks traverse the work zone;

2. where a designated school route traverses the work zone;

3. where significant pedestrian/bicyclist activity or evidence of such activity exists; and

4. where existing land use generates such activity (e.g., parks, schools, shops).

The following guidelines should be considered when addressing pedestrian/bicycle accommodation through construction zones.

1. Physically separated pedestrians and vehicles where practical.

2. Consider providing temporary lighting for all walkways that are currently lighted.

3. Where pedestrian walkways and bicycle paths cannot be provided, direct pedestrians/ bicyclists to a safe location (e.g., the other side of the street).

4. Stage construction operations so that if there are two walkways they are both not out of service at the same time.

5. Plan the construction so that any temporary removal of sidewalks will occur in the shortest practical time or be scheduled around non-peak pedestrian times.

6. For information on handicapped accessibility criteria, see Section 51-1.0.

82-3.0 GEOMETRIC DESIGN

The following sections present design criteria which apply to temporary crossovers on divided highways, existing roadways through construction zones and detours specifically designed for construction projects (e.g., crossovers, runarounds). These criteria do not apply to detours over existing routes.

82-3.01 Construction Zone Design Speed

The construction zone design speed applies to the design of the geometric elements through the work zone. It does not apply to the regulatory speed limits that are used for posting the speed limit through the work zone. Regulatory speed limits are discussed in Section 83-2.03. When selecting the construction zone design speed, the designer should consider the following factors.

1. Posted Speed Limit. The construction zone design speed should take into account the following:

    a. The posted speed limit of the facility immediately prior to the work zone;

    b. the anticipated posted work zone speed limit through the work zone (see Section 83-2.03); and

c. the posted speed limit of the facility before construction begins. The construction zone design speed normally should not be more than 15 km/h below the posted speed limit prior to construction.

2. Urban/Rural. Construction zone design speeds in rural areas should generally be higher than those in urban areas. This is consistent with the typically fewer constraints in rural areas (e.g., less development).

3. Terrain. Lower construction zone design speeds may be applicable for rolling terrains. This is consistent with the typically higher construction costs as the terrain becomes more rugged.

4. Traffic Volumes. For some facilities, the construction zone design speed may vary according to the traffic volumes; i.e., use higher design speeds as traffic volumes increase.

The designer should coordinate with the appropriate district traffic engineer to establish the construction zone design speed for INDOT routes, and the local public agency's engineer for local roads. The designer should show the construction zone design speed on the first sheet of the TCP.

Where crossovers are used to maintain one lane of traffic in each direction on rural Interstates the following will apply.

1. Use temporary concrete median barrier;

2. unless the median shoulder is full depth, it is to be removed and replaced with a 1.8-m section with its pavement design to be requested by the designer;

3. the traffic maintenance should be as shown in Figure 81-3A_0; and

4. shoulder corrugations are to be milled into the new shoulder after traffic is crossed over to the other side.

82-3.02 Lane/Shoulder Widths

Desirably, there will not be a reduction in the roadway cross section width through the construction zone. However, this is often not practical. Section 83-3.02 presents the minimum taper rates that should be used on approaches to lane width reductions. The following lane and shoulder widths should be used in construction zones.

1. Divided Highways. For freeways and other divided highways, at a minimum, maintain a 3.3-m lane width with, preferably, 0.6 m or wider right and left shoulders. Under restrictive

conditions, however, the designer may consider using a 3.0-m lane width if an alternate route is provided for wide vehicles.

2. Undivided Highways. For other road facilities, maintain a minimum 3.0-m lane width and 0.3-m wide shoulder.

3. Runarounds. Design runarounds with 3.6-m lane widths and 1.8-m wide shoulders.

4. Temporary Crossovers. For 1-lane, one-way operations, the lane width should be 5.0 m with 1.5-m wide left and right shoulders. For multi-lane and/or multi-directional operations, each lane width should be 3.6 m wide with 1.5-m left and right shoulders.

82-3.03 Transition Taper Rates

Lane closures, lane width reductions and lane shifts require the use of transition tapers to safely maneuver traffic around the encroaching restriction. Section 83-3.02 presents the minimum taper lengths for various taper applications in construction zones (e.g., lane closures, lane shifts). Use the construction zone design speed when selecting the appropriate taper rate from Section 83-3.02.

82-3.04 Sight Distance

For the approach to the first physical indication of the construction zone, the sight distance available to the motorist should be desirably based on the decision sight distance criteria provided in Section 42-2.0 and, at a minimum, based on the stopping sight distance criteria provided in Section 42-1.0. Through the construction zone itself, the designer should ensure that at least the minimum stopping sight distance is available to the driver. Unfortunately, the location of many design features are often dictated by construction operations. However, some elements may have an optional location. For example, lane closures and transitions should desirably be located where the approaching driver has decision sight distance available to the lane closure on transition. Throughout horizontal curves in the construction area, the designer should check the horizontal clearance (i.e., the middle ordinate) of the horizontal curve using its radius and the minimum stopping sight distance for the construction zone design speed (see Section 43-4.0). Figure 43-4B provides the horizontal clearance criteria for various combinations of minimum stopping sight distances and curve radii. The designer should also consider the percent of trucks and other heavy vehicles in determining controlling sight distances.

Computations must be submitted for horizontal stopping sight distance at the Grade Review or Structure Size and Type stage or the next plan submission (if the project is already beyond the Grade Review or Structure Size and Type stage) for a temporary runaround or other traffic-maintenance means. A statement that a temporary runaround is in accordance with the INDOT *Standard Drawings* is not sufficient to verify that adequate horizontal stopping sight distance is provided.

Computations must be submitted for intersection sight distance for all traffic maintenance phases.

82-3.05 Horizontal Curvature

Design the horizontal curvature using the selected construction zone design speed in Section 82-3.01. For construction zones, use AASHTO Method 2 for distributing superelevation and side friction to determine the radius and superelevation rate of the horizontal curve. In this method, superelevation is introduced only after the maximum allowable side friction has been reached. When compared to AASHTO Method 5, this approach results in no superelevation on flatter curves (i.e., maintaining the normal crown through the curve) and reduced rate of superelevation on the majority of other curves. Figure 82-3A, Minimum Radii for Horizontal Curves (Construction Zones), provides the minimum radii (including the radii for retention of the normal crown section) for horizontal curvature through construction zones based on AASHTO Method 2. For other horizontal curvature elements (e.g., superelevation transition lengths), the criteria presented in Chapter Forty-three is also applicable to construction zones.

Where it is necessary to use the shoulder as a travel lane in the construction zone, the shoulder cross slope may be a concern on horizontal curves (i.e., the slope may be in opposite direction than the superelevated section). One or more of the following options may be considered to alleviate this problem.

1. Rebuild the shoulders so they have the proper superelevation rate based on the selected construction zone design speed,

2. install Advisory Speed plates for the horizontal curve,

3. install buzz strips in conjunction with Item 2 above in advance of the temporary travel lane (see Figure 83-4A, Flare Rates for Temporary Concrete Median Barrier (Construction Zones));

4. restrict large vehicles (trucks) from using the temporary travel lane; or

5. detour large vehicles to other facilities.

82-3.06 Vertical Curvature

Design sag vertical curves in construction zones using the selected construction zone design speed and the comfort criteria presented in Figure 82-3B. The comfort criteria are based on the comfort effect of change in vertical direction through a sag vertical curve because of the combined gravitational and centrifugal forces. In general, riding through a sag vertical curve is considered comfortable when the centripetal acceleration does not exceed 0.3 m/s^2.

82-3.07 Cut and Fill Slopes

Where practical, design temporary cut and fill slopes to meet the design criteria presented in Chapter Fifty-three and Section 45-3.0. However, for construction zones, 3:1 fill slopes may be used where there is sufficient clear zone available at the bottom of the slope (see Section 82-4.04). The use of steeper fill slopes may be considered on a case-by-case basis but may require the installation of roadside barriers.

Although detours rarely involve excavation (cut), 3:1 cut slopes are generally acceptable in place of the flatter slopes presented in Chapter Fifty-three. The use of slopes steeper than 3:1 for cut depths less than 3.0 m may be acceptable under restrictive conditions.

The anticipated traffic volumes and the length of time the detour will be in place should be weighed in determining final cut and fill slopes. In all cases, stable embankment material must be used and placed according to the INDOT *Standard Specifications*.

Drainage should be considered between the work zone and the traffic when establishing the phases of construction.

82-3.08 Maximum Grade

The vertical grade should be designed using the 3R criteria for the appropriate functional classification, rural/urban, and construction zone design speed.

82-3.09 Through-Lane Cross Slope

The 3R criteria should be used for the appropriate functional classification and rural/urban. If the existing shoulder is used for through traffic, a 4% cross slope will be acceptable.

82-3.10 Vertical Clearances

The 3R criteria should be used for the appropriate functional classification and rural/urban.

If the design for a temporary runaround or other traffic maintenance plan excluding detours over existing roads is not in accordance with the criteria for Level One elements, a design exception will be required.

82-4.0 ROADSIDE SAFETY

Through a construction zone, drivers are often exposed to numerous hazards (e.g., restrictive geometrics, construction equipment, opposing traffic). A complete elimination of construction zone hazards is impractical. Nonetheless, the designer must devote special attention to reducing a motorist's exposure to potential hazards. The following sections offer roadside safety criteria which apply only to the roadside elements within the construction zone. These criteria do not apply to detours over existing routes.

82-4.01 Positive Protection

Desirably, the designer should consider traffic control designs which do not require the use of positive protection, minimize the hazard exposure, and maximize the separation of workers and traffic. However, in many construction zones, positive protection is typically required. The locations where the designer should consider using positive protection are as follows:

1. Exposed ends of temporary concrete barriers;
2. untreated guardrail ends in 2-way, 2-lane operations;
3. bridge piers;
4. bridge railing ends;
5. structure foundations (e.g., bridge falsework, sign foundations);
6. excavations and rock cuts;
7. gap in median between dual bridges;
8. pavement edge and shoulder drop-offs in excess of 300 mm; and
9. other locations where construction will increase the potential hazards of existing conditions.

Because each TCP is project-specific, the Department has not developed criteria for positive protection within construction zones. However, a list of factors which should be considered in assessing the need for positive protection is as follows:

1. Duration of construction activity (14 days or less);
2. traffic volumes (including seasonal and special event fluctuations);
3. nature of hazard;
4. length and depth of dropoffs;
5. construction zone design speed;
6. highway functional class;
7. length of hazard;
8. proximity between traffic and construction workers;
9. proximity between traffic and construction equipment;
10. adverse geometrics which may increase the likelihood of run-off-the-road vehicles;
11. two-way traffic on one roadway of a divided highway;
12. transition areas at crossovers; and
13. lane closures or lane transitions.

Other factors may apply, because the above list is not considered to be all-inclusive. The decision regarding the use of positive protection should be documented and placed in the project file.

82-4.02 Appurtenance Types

In addition to Chapter Forty-nine and the INDOT *Standard Drawings*, the following sections provide additional information on the roadside safety appurtenances used by the Department in construction zones.

Positive guidance for crossed-over two-lane two-way traffic should be provided as follows:

1. Temporary concrete barrier and temporary solid yellow lines are to be used on all freeways.

2. Temporary tubular markers and temporary double solid yellow lines are to be used on all other multi-lane divided roadways.

3. Temporary double solid yellow lines are to be used on all urban and rural multi-lane undivided roadways.

Temporary bituminous divider shall not be used for separating traffic.

82-4.02(01) Guardrail

Temporary guardrail installations for Interstate projects should be in accordance with the permanent installation criteria in Chapter Forty-nine and the INDOT *Standard Drawings*, except as shown in Figure 82-4B, Clear Zone Distances (m) (Construction Projects). For short-term construction projects, the installation of a new temporary guardrail is usually not practical.

The following should be used to determine the temporary guardrail length on all four corners of temporary bridges in two-lane runarounds. For construction zone design speeds of less than or equal to 80 km/h, the minimum guardrail length is 15.24 m. For construction zone design speeds of greater than 80 km/h, the minimum guardrail length is 30.48 m.

A temporary guardrail run should continue until the guardrail warrants for embankments shown in Section 49-4.04 are satisfied. The design speed, and not the construction zone design speed, should be used to determine guardrail warrants for embankments.

82-4.02(02) Temporary Traffic Barrier (TTB)

A TTB is used to provide protection to motorists and workers in the work zone. The primary functions of TTB are as follows:

1. to separate two-way traffic;
2. to protect workers and pedestrians;
3. to keep traffic from entering a work area (e.g., excavation, storage site); and
4. to protect construction elements (e.g., bridge falsework, exposed objects).

1. <u>Types of TTB</u>.

    a. Type 1. This type is used only to separate two-way traffic.

    b. Type 2. This type is used to separate traffic from the work zone. It should be used to protect traffic from any obstruction, including an elevation differential of greater than 150 mm, which is within the construction clear zone. It should also be used to shield traffic from extreme hazards during construction that may necessitate consideration of a barrier between the construction clear zone and the permanent clear zone. For this situation, the designer should consider the construction zone design speed, the extent of the obstruction, and the potential for an elevation differential, and use engineering judgment in determining whether a TTB is necessary.

c. Type 3. This is type 1 TTB which is to be left in place upon completion of the contract and become the property of the Department.

d. Type 4. This type is used as a readily movable device to accommodate the shifting of traffic lanes possibly on a daily basis to better facilitate the directional distribution or other changing volumes of traffic during a day's peak hours. The barrier layout and signage for each phase, a staging-area diagram, and the location of the barrier-moving apparatus when it is not in use should be shown on the traffic control plan. The size of the barrier-moving apparatus should be taken as 15 m long by 5 m wide.

2. <u>Construction Clear Zone and Flaring Considerations</u>. The terminal end of a TTB type 1, 2, or 4 should be flared away from the traveled way to a point outside the construction clear zone. Construction clear zone distances are shown in Figure 82-4B. The potentially hazardous conditions typically found within a construction zone warrant the use of considerable judgment when applying one of these widths. It is not necessary to adjust such width for horizontal curvature.

   Figure 82-4A, Flare Rates for Temporary Traffic Barrier, should be used to determine the desirable flare rate for the TTB based on the construction zone design speed, and not a lower worksite speed limit.

   If a flared portion of TTB type 1 cannot be designed to end outside the construction clear zone, an acceptable construction zone energy absorbing terminal as described in Section 83-4.02(03), Item 1, is required. A unit which has been successfully crash tested in accordance with NCHRP 350 Test Level 2 should be specified if the construction zone design speed is 70 km/h or lower. A unit which has been successfully crash tested in accordance with NCHRP 350 Test Level 3 should be specified if the construction zone design speed is 80 km/h or higher.

   For a TTB type 2 or 4, if field conditions such as public road approaches or drives render the desirable flare rate impractical, the flare rate may range between 10:1 and 6:1. For a TTB type 2, the flare may be eliminated if the sharper flare rate cannot be attained. Such locations and flare treatments should be shown on the traffic control plan.

3. <u>Glare Screen</u>. A glare screen may be used in combination with TTB type 1 or type 3 to eliminate headlight glare from opposing traffic. Guidance regarding consideration of glare screens is described in Section 49-4.05(03).

4. <u>Traffic-Control-Plan Information</u>. Types, locations, and quantities of TTB, including locations and quantities of glare screens and energy absorbing terminals, along with flare rates should be shown on the traffic control plan for each traffic-maintenance phase.

See Section 17-3.13 for information regarding determination of pay quantities.

82-4.02(03) End Treatments

The following discusses several end treatments that may be used.

1. Energy Absorbing Terminals. The use of construction zone energy absorbing terminals should be based on National Cooperative Highway Research Program Report 350 Test Levels. The Test Level 3 (TL-3) terminal should be specified for all Interstate and other routes with a construction zone speed limit in excess of 45 mph. The TL-2 terminal should be specified for all non-interstate routes with a construction zone speed limit of 45 mph or lower. If a lower temporary worksite speed limit is to occasionally apply, all terminals' Test Levels should still correspond to those for the construction zone speed limit. Locations of terminals with their Test Levels should be shown on the TCP.

2. Guardrail. The treatments for exposed ends of guardrail include the following:

    a. Connection to existing barriers;
    b. using an acceptable end treatment (use the construction year AADT, and see Section 49-5.04(01));
    c. flaring the end to a point outside of the construction clear zone; or
    d. burying the end in the backslope.

3. Gravel Barrel Array. Due to the size of the array, gravel barrel arrays generally have limited application in construction work zones.

4. Other. Other INDOT approved end treatments may be applicable. Chapter Forty-nine provides information on some of these end treatments used by the Department. Provide the most applicable end treatment consistent with cost and geometric considerations.

82-4.02(04) Glare Screens

Glare screens can be used in combination with the TCB to eliminate headlight glare from opposing traffic. Typical applications in construction zones are at crossover transitions and in 2-way, 2-lane operations. Where glare screens are considered, the designer should evaluate the design criteria in Section 49-4.05. INDOT has not adopted specific warrants for the use of glare screens.

82-4.03 Design/Layout

Where practical, temporary roadside safety appurtenances should be designed and located as determined in Chapter Forty-nine (e.g., deflection distance, length of need). However, it is usually not cost effective to meet these permanent installation criteria due to the limited time a motorist is exposed to construction hazards. The designer will need to evaluate the exposure time of the hazard in determining the need for installing a roadside safety appurtenance. The following offers several alternatives the designer may consider in designing and locating temporary roadside safety appurtenances within construction zones.

1. Construction Clear Zones. Applying the clear zone distances as presented in Chapter Forty-nine, to construction work zones is often impractical. Therefore, INDOT has developed revised construction clear zone distances for construction projects which are presented in Figure 82-4B. However, the potentially hazardous conditions typically found within construction zones warrant the use of considerable judgment when applying these clear zone distances. Note that it is not necessary to adjust the clear zone values presented in Figure 82-4B for horizontal curvature.

2. Shoulder Widening. Where a temporary barrier is placed adjacent to the shoulder, it is not necessary to provide extra shoulder widening.

3. Flare Rates. Desirably, the TCB terminal should be flared beyond the traveled way to a point outside of the construction clear zone. Figure 82-4A presents the desirable flare rates for the TCB based on the selected construction zone design speed. The designer should provide these flare rates unless extenuating circumstances render this impractical (e.g., stop conditions, driveways, intersections). See Section 82-4.03.

5. Openings. Openings in the barriers should be avoided. Where openings are necessary, barrier ends should have an acceptable end treatment as discussed in Section 83-4.03(03).

82-4.04 Pavement Edge Dropoffs on Multilane Divided Highways

Pavement edge dropoffs should be avoided immediately adjacent to lanes open to traffic during construction activities such as shoulder rehabilitation and crossover construction.

When developing a traffic maintenance plan, the preferred option is to close the lane adjacent to an edge dropoff. This will ensure that the edge dropoff is located beyond the recommended construction clear zone.

If the traffic lane adjacent to the edge dropoff cannot be closed for an extended period of time, a full-depth shoulder rehabilitation section should be provided that can be placed to within 75 mm of the top of pavement elevation by the end of the work period. This should be done, for example, where the shoulder work is to be done at night so that all of the existing traffic lanes can be kept open during daylight hours. The pavement section required to fill a shoulder dropoff to within 75 mm of the top before exposure to adjacent traffic should be obtained from the Materials and Tests Division's pavement design engineer. A unique special provision will be required to address the time frames imposed on the contractor for bringing the shoulder paving up to the required grade. Also, drums should be placed on the shoulder dropoff, spaced as shown in Figure 83-3D, Suggested Maximum Spacing of Channelization Devices.

Where it is not feasible to limit exposure to the edge dropoff by the means described above, and the edge dropoff is greater than 75 mm, one of the mitigating measures should be considered as follows:

1. Placing a temporary wedge of material along the face of the dropoff. The wedge should consist of asphalt material placed at a 45 deg angle or flatter. Warning signs should be placed in advance of and throughout the treatment. A 150-mm width solid edge line should be used to delineate the edge of the travel lane.

2. Placing drums along the traffic side of the dropoff and maintaining, if practical, a 1-m width buffer between the edge of the travel lane and the dropoff. Warning signs should be placed in advance of and throughout the treatment.

3. Installing temporary concrete barriers or other acceptable positive protection with a buffer between the barrier face and the traveled way. An acceptable crashworthy terminal or flared barriers should be installed at the upstream end of the section. For nighttime use, standard delineation devices must supplement the barriers. Specifying the use of a temporary movable concrete barrier system will generally involve the use of proprietary materials.

On projects involving deep milling or asphalt pavement replacement, and a dropoff greater than 40 mm between adjacent lanes, mitigating measure No. 1 or No. 2 should be considered.

82-5.0 HIGHWAY CAPACITY

82-5.01 Traffic Capacity Analysis

The need for traffic capacity analyses during the development of the traffic control plan will be determined on a project-by-project basis. Freeway reconstruction projects are generally candidates for analysis as are other project types under similar conditions. Maintaining an acceptable level-of-service during construction is especially important on freeways and on high-speed rural highways.

Desirably, the operational elements of a road facility under construction (e.g., lane segments, ramps, intersections) should maintain a level-of-service which is not significantly less than that provided by the facility prior to construction, although this is not always attainable. Achieving this may require the following:

1. converting shoulders to travel lanes;
2. eliminating on-street parking (during peak hours or at all times);
3. constructing temporary lanes;
4. opening additional lanes during peak periods;
5. providing public transportation;
6. constructing jug-handles for indirect left-turns at intersections;
7. closing or metering ramps at interchanges;
8. providing turnouts along long, restrictive stretches of highway construction;
9. constructing passing blisters at "T" intersections;
10. providing two-way, left-turn lanes on urban facilities;
11. adjusting signal phasing and timing at intersections;
12. providing additional turn lanes at intersections;
13. lengthening turn lane storage bays;
14. adjusting acceleration/deceleration lengths at interchange ramps;
15. closing intersections;
16. restricting turns at intersections;
17. providing extra pavement widths;
18. providing signal or flagger control in 1-lane, two-way operations;
19. public information; or
20. temporary ramp connections.

82-5.02 Queuing Analysis

The Department requires that traffic control plans developed for freeway reconstruction projects include, at a minimum, a queuing analysis to determine the anticipated traffic backups at particular times of the day. The results of the queuing analysis should be included with the proposed TCP and should be used to determine whether or not to consider the following:

1. Restricting construction operations to off-peak hours and/or night operations,
2. closing a ramp,
3. using alternate routes,
4. developing public relations strategies, or
5. temporary widening for extra lane or roadway capacity.

When a queuing analysis is required, the designer should use the FHWA computer program QUEWZ or other approved programs to accomplish this task. QUEWZ is designed to evaluate freeway work zones, but the designer may find it useful for other multilane highways. Section 81-4.0 provides additional information on this program. The program can provide the following:

1. Estimation of vehicular capacity through work zones,
2. calculation of average speeds,
3. calculation of delay through a lane closure section,
4. calculation of queue,
5. estimate of diverted traffic, and
6. total user cost.

82-6.0 APPLICATIONS

Section 81-2.0 discusses the factors to consider when determining which construction application to use. The following sections provide some of the design considerations for several of these applications.

82-6.01 Lane/Shoulder Closures

In addition to the INDOT *Standard Drawings*, the designer should consider the following for lane/shoulder closures.

1. Tapers. Lane closures, lane width reductions and lane shifts require the use of transition tapers to safely shift traffic around the encroaching restriction. The designer should review Sections 82-3.03 and 83-3.02 for information on transition tapers.

2. Sight Distance. Desirably, provide decision sight distance to the beginning of the lane closure or transition. Section 82-3.04 provides additional information on sight distances within the construction zones.

3. Lane Widths. Section 82-3.02 provides the Department's criteria for reduced lane widths.

4. Shoulder Usage as Travel Lane. If the Traffic Maintenance Plan involves traffic placement of traffic on the shoulder or a portion of the shoulder, the designer should make a written request to the Materials and Tests Division's pavement design engineer, with a copy to the appropriate project coordinator, regarding the shoulder's use. The construction year AADT,

percent trucks of AADT, and the approximate duration of traffic on the shoulder should be provided.

The median shoulder should be replaced with a 1.8-m wide section. See the INDOT *Standard Drawings.* The proposed median shoulder for the new pavement section constructed in the first phase should also be 1.8 m wide. Its pavement design should be provided by the Materials and Tests Division's pavement design engineer. Such shoulder will carry traffic during subsequent phases. The entire 1.8 m width should remain in place. Shoulder corrugations are to be milled into the new shoulder after traffic is crossed over to the other roadway.

5. Lane Closure. The length of a lane closure should be a minimum so that the motorist is not passing long sections of closed lanes where no work activity is occurring.

6. Roadside Safety. Do not use roadside barriers as transition devices. Transitions should be provided with the appropriate traffic control devices (see Chapter Eighty-three). Provide sufficient distance between the transition devices and roadside barrier to allow an errant motorist to safely return to the traveled way. Roadside barriers (e.g., temporary concrete barrier) may be used as channelization devices beyond the taper. Where shifting traffic next to roadside barriers, the shy distance, as discussed in Section 49-5.0, desirably should be provided.

7. Traffic Control Devices. Chapter Eighty-three and the INDOT *Standard Drawings* provide the Department's criteria for the placement of traffic control devices.

8. Bridges. Figure 82-6A, Lane Closures on Bridges, illustrates a work zone traffic control plan for closing a lane on a bridge reconstruction or rehabilitation project. Figure 82-6A is applicable to a 9.0-m wide structure on a 4-lane divided facility. The designer will need to adjust the design to meet other situations. Figure 82-6A provides the details for a left-lane closure. These details may also be used for a right-lane closure.

9. Roadway Under Overpass Structure. Work which includes full-depth bridge deck patching, structure removal or placement not protected by bridge railings, or other work activities that affect underpassing lanes that are open to traffic, may not take place directly above such lanes. Appropriate warning signs and traffic control devices should be provided on the underpassing roadway to warn motorists of lane closures for such work. Such signs and devices are required even if no work is being done on the underpassing roadway.

82-6.02 Two-Way Traffic on a Divided Highway

The following provides several design considerations where two-way traffic on a single roadway of a divided highway is used.

1. Length. The optimum segment length of two-way traffic on a divided highway is considered to be less than 6 km. Where the segment length exceeds 6 to 8 km, operational efficiency may be severely reduced as traffic backs up behind slower vehicles.

2. Positive Protection.

    a. Freeway. Temporary concrete barrier along with temporary solid yellow lines as shown on the INDOT *Standard Drawings* should be used within each crossover and between the crossovers to separate opposing traffic.

    b. Other Multilane Roadway. Tubular markers should be used to enhance the delineation and separation of the opposing traffic flows on each side of a temporary double solid yellow line. The tubular markers are placed onto the pavement between the solid yellow lines as shown on the INDOT *Standard Drawings*.

       Where construction activities require temporary revision of traffic patterns within the construction zone to two-lane two-way operation at or near an intersection, the end of the temporary double solid yellow line should match the end of the existing broken white lane line.

       For a roadway with lanes which are narrower than 3.6 m without paved or aggregate shoulders, compacted aggregate size No. 73 is required where slope and ditch conditions permit, as shown on the INDOT *Standard Drawings*. Such conditions must be assessed when developing the traffic control plan. The cross slope of each temporary compacted aggregate shoulder is to be as shown on the INDOT *Standard Drawings*. Quantities for the compacted aggregate must be determined.

3. Roadside Safety. Where traffic is directed onto the opposing roadway, the designer should consider the effect this will have on the operational characteristics of roadside appurtenances. For example, existing trailing ends of unprotected bridge rails may require approach guardrail transitions or impact attenuators, or blunt guardrail terminals may need to be protected with an acceptable end treatment.

4. Crossovers. The following should be considered in the design of crossovers.

    a. Tapers for lane drops should not be contiguous with the crossover. See Section 82-3.03 for acceptable taper rates and lengths.

b. The crossover should have a construction zone design speed that is no more than 15 km/h below the posted speed limit before the construction zone; see Section 82-3.01.

c. The crossover design should accommodate the anticipated truck traffic of the roadway (e.g., surfacing widths, loads).

d. A clear recovery area should be provided adjacent to the crossover; see Section 82-4.04.

e. Temporary concrete barriers and the excessive use of traffic control devices cannot compensate for a poor geometric design of crossovers.

5. Signing. Provide signing prior to the crossover to indicate the length of the 2-way, 2-lane section. In addition, signing may be provided within the 2-lane section indicating the remaining distance of the 2-lane section.

6. Interchanges. Desirably, maintain access to interchange ramps on a freeway even if the work space is in the lane adjacent to the ramps. Additional crossovers for the purpose of maintaining full interchange access may be required. If interchange access is not feasible or presents a capacity problem, ramps should be closed using proper detour signing for alternative routes. Where ramp closures are deemed necessary, early coordination should be conducted with local officials having jurisdiction over the affected cross roads or streets. The designer should also check that sufficient deceleration and acceleration distances are maintained where there is work in the vicinity of interchange ramps. If this is not practical, additional traffic control devices or closing the ramp may be required. The designer should review the safety aspects and conduct a capacity analysis to determine the appropriate action.

7. Capacity. Conduct a capacity analysis to ensure that the traffic can be reasonably handled in the one lane. If not, then an alternate construction application should be considered (e.g., lane shifts to the shoulder).

   The needs of left-turning vehicles should be considered when developing phase-construction schemes that reduce a multilane road to one lane in each direction.

82-6.03 Interstate Highway Lane Closures

Past work-zone traffic-maintenance practices should be consolidated with new requirements to eliminate or reduce traffic delay caused by work zones on Interstate routes. Central to this consolidation is managing the capacity to maintain traffic flow. Ultimately this will enhance customer satisfaction while traveling through such work zones.

1. <u>General Requirements</u>. Figure 82-6B, Interstate Lane Closure Policy – Statewide, and Figure 82-6C, Interstate Lane Closure Policy – Selected Urban Areas, define the allowable times during which lanes may be closed on Interstate routes. This policy is based on the threshold of lane restrictions which may generate up to a 1.6-km queue or 10-min road user delay, and applies to all contracted expansion, preventative maintenance, and planned maintenance activities, except for work activities denoted in INDOT's *Work Management System as Performance Standards* performed by INDOT personnel.

   At the times when an Interstate route is designated as an alternate/detour route for another Interstate route, the allowable times for lane closures shown in the figures will not apply. Only work designated as "Emergency" may be performed during this time.

2. <u>Determining Lane Closures Based on Maps in Figures</u>. Figures 82-6B and 82-6C illustrate where and at what times restrictions may be present along the rural portions of Interstate routes.

Time descriptions are defined as follows:

a. Anytime. One lane may always be closed in each direction.

   b. Weekend or Nighttime Only. One lane may be closed in each direction from Friday 9:00 p.m. through Monday 6:00 a.m., and weekdays from 9:00 p.m. to 6:00 a.m. along a route with significant commuter traffic.

   c. Weekday or Nighttime Only. One lane may be closed in each direction except from Friday 6:00 a.m. to Sunday 9:00 p.m. along a route which experiences significant increases in traffic during the weekends.

   d. Nighttime. One lane may be closed in each direction nightly from 9:00 p.m. to 6:00 a.m. along a route with heavy traffic where queues longer than 1.6 km can be expected during the daylight hours.

   e. Executive Approval. Such approval is required for one lane to be closed in each direction along a rural four-lane route with Average Annual Daily Traffic (AADT) greater than 50,000. Except for conditions designated as Emergency, approval by the Chief Engineer for a Design Division-developed project, or the Deputy Chief of Highway Operations for a district-developed project, is required before any lane closures may be shown on the TCP.

f. Minimum Two Lanes in Each Direction. A minimum of two lanes in each direction should be open at all times along an urban route with six total lanes and AADT greater than 100,000.

g. Minimum Three Lanes in Each Direction. A minimum of three lanes in each direction should be open at all times along an urban route with eight total lanes or more.

3. Determining Lane Closures Independent of Maps in Figures. If an operation is to restrict or extend lane closures during times not shown on Figure 82-6B or 82-6C, the designer/planner should complete a quantitative analysis and a traffic management plan with the request for an exception. For all repairs deemed Emergency, see Item 6 below.

The Environment Planning and Engineering Division's Engineering Assessment Section, the Design Division, or district development should analyze the impact on the motoring public of any proposed lane closure not permitted by Figure 82-6B or 82-6C.

For contract work, the analysis should occur during the planning process after the pavement recommendation has been formulated and/or bridge work has been determined. The analysis should always occur before beginning scoping of the final design.

For a Design-Build project, the Traffic Management Plan will be completed, approved, and reflected in the scope of services.

Analysis of permit or force account work zone impacts should occur prior to the implementation of any lane restrictions.

4. Qualitative Analysis. A quantitative analysis should be performed to determine queues that will be generated any time a lane closure is proposed for times not shown on Figure 82-6B or 82-6C.

a. Projected Queue Shorter than Threshold Length. The final development process may commence. Documentation of the analysis must be retained on file. Any work zone strategy chosen that will result in impacts of less than the allowable delay thresholds but increases the project cost by 20% or $1,000,000 should be submitted to the Chief Engineer for approval.

b. Projected Queue Equal to or Longer than Threshold length. An exception request should be submitted to the Chief Engineer or Deputy Commissioner of Highway Operations. The exception request should identify the alternative selected as the preferred option and the reasoning for the selection. The exception request should also address the impact on the current INSTIP program if the request were to be denied.

5. Traffic Management Plan (TMP). The TMP should be completed for the strategy selected and should incorporate the applicable additional elements as follows:

    a. consideration of stakeholders' needs during the decision-making process;

    b. incident management strategies;

    c. public relations campaign; and

    d. identification of alternate routes.

6. Emergency Repairs. All repairs deemed as Emergency which occur at times not shown on Figure 82-6B or 82-6C will not require prior approval before a lane closure action is taken. Such repairs include, but are not limited to, pavement or bridge deck failures, bridge structure impact damage, roadside appurtenances, and slope stability. Notification of the closure must satisfy current Departmental procedures.

7. Routine District Maintenance. Some non-contractual routine maintenance activities, such as crack sealing, pavement markings, raised-pavement-markers restoration, etc., are performed on a recurring basis by district maintenance forces. Such activities are exempt from this policy and are addressed under a separate *District Maintenance Interstate Lane Closure Policy* developed by the districts and the Operations Support Division.

8. Queue Analysis. The criterion used to determine the impact of proposed work zones will be queue length. QuickZone, Quewz-92, Synchro/Simtraffic, Corsim, or similar programs may be used to model the expected queues that may be generated. Multiple stages of construction should be analyzed for each of the traffic-maintenance phases. The speed limit used in the computer models should be the posted legal construction-zone speed limit. Volume data supplied by INDOT for input into the models should be current (not older than three years), should account for seasonal traffic surges that may occur during construction, and should reflect current regional traffic patterns. Traffic volumes should be expanded to construction-year levels through the use of growth factors. In urban areas where congestion occurs under normal unrestricted conditions, the queue length should be considered.

    Use of a microscopic model (Synchro/Simtraffic, Corsim, etc.) is encouraged for modeling of work zone queues. The effect of significant ramp merges on queues should be included in the model.

    A vehicle will be considered part of a queue if its average operating speed is approximately

15 km/h or less. Discretion is required during both the analysis portion and field evaluation of the implemented work zone in determining what constitutes a queue. A condition that causes driver frustration due to stop-and-go operations should be considered a queue.

The following thresholds should be used for the evaluation of project queue lengths as determined by the computer model.

a. For a queue shorter than 1.6 km, the work zone impacts are acceptable.

b. For a queue of 1.6 km or longer but shorter than 2.5 km, the work zone impacts are acceptable if the queue exceeds 1.6 km for 2 h or less. Where a queue is expected, additional advanced work zone warning signing should be specified.

c. For a queue of 1.6 km or longer for more than 2 h, or for a queue of 2.5 km or longer for any period of time, the work zone impacts are unacceptable. Alternate strategies should be considered based on this policy.

82-6.04 Runarounds and Detours

In addition to the criteria on the INDOT *Standard Drawings*, temporary runarounds and specially built detours should meet the geometric and roadside safety criteria presented in Sections 82-3.0 and 82-4.0.

The embankment for a temporary runaround should be shown on the mainline cross sections.

If the AADT is greater than 5000 or if the percent trucks (ADTT) is greater than 10%, a pavement design is required for a temporary runaround. See the INDOT *Standard Drawings.*

** *PRACTICE POINTER* **

Unofficial detour routes should not be shown on the plans or in the special provisions.

A temporary runaround should comply with the design criteria included herein. The following Level One elements shall meet the criteria as follows:

Elements	Design Criteria

1.	Design speed	Section 82-3.01
2.	Lane width	Section 82-3.02
3.	Shoulder width	Section 82-3.02
4.	Bridge width	Standard Specifications Section 713.04
5.	Structural capacity	Standard Specifications Section 713.04
6.	Horizontal curvature	Figure 82-3A
7.	Superelevation transition length	Section 82-3.05 and Chapter 43
8a.	Stopping sight distance at horizontal curve	Section 82-3.04. Design speed should be used in the construction zone. Section 43-4.0
8b.	Stopping sight distance at vertical curve	Sag: Section 82-3.06; Crest: Section 82-3.04 and Chapter 44.
9.	Maximum grade	3R criteria for the design speed for the construction zone, appropriate functional classification, and rural/urban.
10.	Through lane cross slope	3R criteria for the appropriate functional classification and rural/urban. If the existing shoulder is used for through traffic, 4% cross slope will be acceptable.
11.	Superelevation rate	Section 82-3.05
12.	Vertical clearance	3R criteria for the appropriate functional classification.
13.	Americans with Disabilities Act requirements	Section 51-1.08, where sidewalks exist prior to construction.
14.	Bridge railing safety performance	Standard Specifications Section 713.14

If the design for a temporary runaround or other traffic-maintenance means does not meet the above criteria, a design exception must be requested. The procedure established in Section 40-8.0 should be followed.

The INDOT reviewer should verify that the above criteria are met as part of the limited review of a consultant-designed project.

The design speed for the construction zone should be shown on the first sheet of the Traffic Maintenance Plan. The designer should coordinate with the appropriate district traffic engineer to establish the design speed for the construction zone for an INDOT route or with the local public agency’s engineer for a local agency project.

82-7.0 TRAFFIC CONTROL PLANS CHECK LIST

A traffic control plans check list is shown as Figure 82-7A.